CHAPTER 1

INTRODUCTION

1.1 GENERAL

Water as a vital natural resource for human survival has been well-established. Water from beneath the ground has been exploited for domestic use, livestock and irrigation since the earliest times. Although the precise nature of its occurrence was not necessarily understood, successful methods of bringing the water to the surface have been developed and groundwater use has grown consistently ever since (Chilton, 1992). The choice of underground water is obviously on the basis of superior quality, low capital cost of development, development in stages to keep pace with rising demand and convenient availability close to where water is required (Barthel et al., 2009; Bansal et al., 2010).

Since groundwater often occurs in association with geological materials containing soluble minerals, higher concentrations of dissolved salts are normally expected in groundwater. The type and concentration of these salts depend on the geological environment, the source and the movement of water. The natural (geogenic) quality of groundwater is, therefore, controlled by the geochemistry of the lithosphere, the solid portion of the earth, and the hydrochemistry of the hydrosphere, the aqueous portion of the earth. Physico-chemical reactions between soil or rock and water are of considerable importance when evaluating or predicting groundwater quality (Aremu et al., 2002; Ali et al., 2003; Babiker et al., 2004; Thyne et al., 2004; Bekele, 2006; Yalcin et al., 2007; Andrade and Stigter, 2009). Apart from these geogenic factors, other anthropogenic influences such as industrial waste disposal (Younger, 2007; Gamper, 2009; Sood et al., 2013); land filling (Haifeng et al., 2008; Dong et al., 2009), nonpoint source pollution (Engel et al., 1996; Wong et al., 1997; Boyle, 2001; Singh et al., 2004; Worralla and Besienb 2005; Ahmed, 2009), artificial recharging (Nolan, 2003; Yadav et al., 2007; Bansal et al., 2008a) etc. affect the quality of groundwater. Therefore, groundwater quality is the sum of geogenic and anthropogenic influences.
1.2 GROUNDWATER QUALITY ASSESSMENT

There have been several studies reported on the assessment of groundwater quality of different regions (Camp et al., 1994; John and Sarmah, 1997; Dhiman and Kesri, 2002; Garg et al., 2004; Rahman et al., 2005; Shihab, 2005; Fawell et al., 2006; Bathusha and Saseetharan, 2007; Amini et al., 2008; Al-Chalabi and Khalil, 2008; Dong et al., 2009; Lin et al., 2009; Yan et al., 2009). Each assessment programme was designed to meet a specific objective, or several objectives, which were, in each case, based on the relevant quality parameters related to the specific issues and water uses addressed.

Wilkinson and Edworthy (1981) defined that the overall goal of a groundwater quality assessment programme, was to obtain a comprehensive picture of the spatial distribution of groundwater quality and of the changes with time that occur, either naturally, or under the influence of man. However, in practice, most of the groundwater assessment systems are limited to generating data with regard to levels of parameters defining groundwater quality. Often, much less thought and research efforts have gone into the data management phase of groundwater quality assessment. Therefore, to meet the above goals of the groundwater quality assessment programme, what is required is to process and translate these data into information which can be used for groundwater quality management. The benefits of comprehensive and appropriate groundwater quality information are timely water quality management, and/or pollution control measures, that can be taken based on it (Bellot and Ershownz, 1991; Davis et al., 2003; Brink et al., 2008; Chen et al., 2008, Yan et al., 2009). This process obviously requires tool(s) which are capable of dealing with diverse and voluminous data on a single platform (Cools et al., 2006). It is reported that the Geographical Information System (GIS) can provide an appropriate platform for efficient processing and analysis of diverse data sets for decision making in groundwater management and planning (Clarke, 1986; Barroc and Biallo, 1993; Greene and Cruise, 1995; Madon and Sahay, 1997; Wong et al., 1997; Miles and Carlton, 1999; Gogu et al., 2001; Chowdhary et al., 2004; Portoghese et al., 2005; Yanbing, 2006; John et al., 2006; Asadi et al., 2007; Al-Qudah and Abu-Jaber, 2009; Dixon, 2009, Bansal et al., 2011).
1.3 SIGNIFICANCE OF THE STUDY

Chandigarh (India) is fast emerging as one of the most advanced cities of India. It is located at the Shivalik Foot Hills. The city’s population was 9 lakh in 2001 and is expected to grow to 15 lakh by 2031. Presently, the city receives about 325 MLD water from Bhakra Main Canal and 70 MLD water from deep tubewells. The projected demand in the year 2021 is 720 MLD and the gap between supply and demand of water is to widen and touch 276 MLD. As the canal water supply is not likely to be augmented in the near future due to the interstate water policies, the city is expected to depend on groundwater to meet the enhanced water demand. In view of this, it is intuitive to initiate studies to improve the existing groundwater management system and develop models for the same. Also, it is imperative to use the versatility of GIS for the management of the groundwater quality of the region. Therefore, the major thrust of the study is to improve the existing database management of groundwater resources in Chandigarh (India) using GIS platform.

1.4 OBJECTIVES OF THE STUDY

The major objective of the study is to develop a comprehensive database management system for the various geochemical quality parameters in the groundwater vis-à-vis subsurface lithology of the study area. A GIS based analysis of the database is performed to find out temporal as well as spatial variations of geochemical parameters of groundwater quality of the region. To achieve this major objective, the following specific objectives are identified:

1. To prepare the hydro-geological database of the study area on GIS platform
2. To assess and map the groundwater quality of the study area
3. To find out temporal as well as spatial variations of geochemical parameters defining quality of groundwater in the study area in a GIS environment
4. To develop suitable interactive models using GIS to obtain further insights into the hydrogeology of the study area
5. To demonstrate the use of such models in groundwater management.
1.5 ORGANISATION OF THE THESIS

The thesis comprises nine chapters followed by a list of references.

Chapter 1 gives a brief introduction to the problem; broadly outlining the significance and objectives of initiating the work is described in.

Chapter 2 presents a brief overview of the study area especially the geographical settings and climatological information vis-à-vis population trends and water demand.

Chapter 3 reviews the pertinent literature on groundwater, geochemical analysis, GIS based groundwater management system.

Chapter 4 presents research protocol describing the genesis, objectives, scope and a flow diagram indicating the steps followed are presented in.

Chapter 5 deals with the materials used and the general methodology adopted.

Field study and laboratory studies were conducted on the groundwater resources in the study area.

Chapter 6 deals with the spatial and temporal variation in groundwater quality of the study area. A GIS based multivariate analysis of the various groundwater quality parameters along with the hydro-geological classification of the water is also presented.

Chapter 7 presents the comprehensive GIS based groundwater management tools.

Chapter 8 summarizes the conclusions of the study.

Chapter 9 proposes the scope of the future work based on the limitations and observations of the present study.